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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/045,542	10/26/2001	Mrinal Kanti Das	5308-1571P2	3570
20792	7590	10/28/2004	EXAMINER	
MYERS BIGEL SIBLEY & SAJOVEC			JOLLEY, KIRSTEN	
PO BOX 37428				
RALEIGH, NC 27627			ART UNIT	PAPER NUMBER
			1762	

DATE MAILED: 10/28/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/045,542

Applicant(s)

DAS ET AL.

Examiner

Kirsten C Jolley

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 15 July 2004.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,3-9,12-14 and 16-20 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,3-9,12-14 and 16-20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 6/4/04, 7/29/04, 9/23/04, 2/6/04, 1/22/04,
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

11/10/03

DETAILED ACTION

Response to Arguments/Amendments

1. Applicant's arguments have been considered but are moot in view of the new ground(s) of rejection. The rejections set forth in the prior Office action have been withdrawn, and new rejections are applied below. Accordingly, this action is being made non-final.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claim 8 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 8, lines 5-8, the phrase "wherein the step of annealing the nitrided oxide layer comprises heating the nitrided oxide layer to a temperature of greater than about 400 C in a hydrogen containing environment *as part of a processing step other than a processing step that is only an anneal* of the nitrided oxide layer in a hydrogen containing environment" [emphasis added] is vague and indefinite because the phrase is confusing and it is not clear what is being claimed. Clarification is required.

Claim Rejections - 35 USC § 102

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4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 6-7 are rejected under 35 U.S.C. 102(b) as being anticipated by Wang, Luo, and Ma's "High-Temperature Characteristics of High-Quality SiC MIS Capacitors with O/N/O Gate Dielectric" (hereinafter "Wang et al").

With regard to claim 6, Wang et al. teaches a method comprising the steps of: fabricating an oxide layer on a silicon carbide substrate; fabricating a nitride on the oxide layer so as to nitride the oxide layer, whereby both the oxide and nitride layers are formed by JVD; and annealing the nitrified oxide layer in an environment comprising water vapor at 950 C (see "Experiments" section).

Alternatively, with regard to claims 6 and 7, Wang et al. teaches a method of depositing an oxide layer on a silicon carbide substrate, and then depositing a nitride layer using SiH_4 and N_2 . During this step, the reagent molecules are decomposed, exposing the substrate surface to N radicals as well as H radicals. Consequently, during this step, the underlying oxide layer is simultaneously nitrified and hydrogenated.

6. Claims 1, 3-4, 6, 9, 12, and 18-20 are rejected under 35 U.S.C. 102(b) as being anticipated by JP 2000-252461 A.

JP '461 discloses providing oxide "and/or" nitride films on a 4H polytype silicon carbide substrate (or on a substrate having silicon carbide as the top layer), then annealing the layers in

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an environment containing hydrogen at temperatures from 600-1600 C. The computer translation of JP '461 teaches that a two-layer film of an oxide film and/or a nitride film may be applied as the insulator layer in paragraph [0006], which is inclusive of a first layer of oxide and a second layer of nitride formed therein, producing a nitrided oxide film. Further, the Derwent abstract of JP '461 (cited on the attached PTO-892) states that "An oxide film and nitride films are formed as a gate insulating film on a semiconductor substrate consisting of silicon carbide in uppermost layer", and the Derwent title of the publication states "Semiconductor device manufacturing method involves annealing semiconductor substrate on which oxide and nitride films are formed..." Therefore, the Derwent abstract clearly teaches that both oxide and nitride films may be formed on the same silicon carbide substrate.

As to the temperatures used, it is noted that annealing temperatures of 500 C, 600 C, and 700 C are taught in paragraph [0021] of the computer translation, and JP '461 teaches an annealing time of 30 minutes. JP '461 teaches using a 4H polytype silicon carbide substrate in paragraphs [0007] and [0008].

It is noted that the claims are rejected under 35 USC 102(b) because the priority references do not provide support for a step of fabricating a *nitrided* oxide layer.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over JP 2000-252461

A.

JP '461 is applied for the reasons discussed above in section 6. JP '461 teaches using a forming gas comprising hydrogen and inert gas as the annealing environment, however JP '461 lacks a teaching of using 4% hydrogen and 96% inert gas. Paragraphs [0016]-[0017] disclose that the hydrogen concentration should be in the range of 0.5% to 100% of the gas. Overlapping ranges are *prima facie* evidence of obviousness. It would have been obvious to one having ordinary skill in the art to have selected the portion of JP '461's hydrogen concentration range that corresponds to the claimed range. *In re Malagari*, 184 USPQ 549 (CCPA 1974).

9. Claims 1-5, 8-9, 12-14, and 16-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xu, Lai, Chan, Li, and Cheng's "Improved Performance and Reliability of N₂O-Grown Oxynitride on 6H-SiC" (hereinafter "Xu et al.") in view of JP 2000-252461 A.

With respect to claims 1, 4-5, 8-9, 12, and 17-20, Xu et al. discloses the claimed process of fabricating a nitrided oxide layer on a silicon carbide substrate, followed by a step of annealing in a forming gas environment (which comprises hydrogen) at 410 C for 30 minutes (see "Experiments" section, specifically the formation of N₂ON samples). Xu et al. teaches use on 6H-SiC wafers, and lacks a teaching of the use of 4H polytype silicon carbide.

JP '461 is cited for its teaching of applying oxide and/or nitride film on a silicon carbide layer, whereby the silicon carbide layer may be 6H polytype SiC or 4H polytype SiC; JP '461 discloses that the two silicon carbide materials provide similar and equivalent results (see paragraphs [0007] and [0008] of the computer translation of JP '461, cited in a previous Office

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action). It would have been obvious for one having ordinary skill in the art to have substituted 4H-SiC for 6H-SiC upon seeing the prior art of JP '461 with the expectation of equivalent results in the absence of a showing of criticality.

As to claim 3, Xu et al. lacks a teaching that the silicon carbide layer is a layer on a non-silicon carbide substrate. JP '461 is also cited for its teaching that the silicon carbide layer on which a nitride and/or oxide layer is formed may be the top layer of a non-silicon carbide substrate as an alternative to using an entirely silicon carbide substrate (paragraphs [0007] and [0008]). It would have been obvious for one skilled in the art to have substituted a substrate having a top layer of silicon carbide for a substrate made entirely of silicon carbide in the process of Xu et al. with the expectation of equivalent and successful results since JP '461 teaches that both types of substrates are equivalent in a process of building a semiconductor device.

As to claims 14 and 16, Xu et al. teaches that the annealing step is preceded by forming metallization using aluminum for a semiconductor device.

As to claim 17, it is noted that an engineer skilled in the art would have been motivated to determine the optimum forming gas concentrations through routine experimentation in the absence of a showing of criticality.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

It is noted that Lai et al.'s article "Interface Properties of N₂O-Annealed NH₃-Treated 6H-SiC MOS Capacitor" discloses fabricating an oxide layer on a SiC substrate, performing


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annealing in pure N_2O , followed by a forming gas anneal at 410 C for 30 minutes. Lai et al. teach in the first column of page 48 that the N_2O anneal incorporates nitrogen near the SiC/SiO₂ interface.

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kirsten C Jolley whose telephone number is 571-272-1421. The examiner can normally be reached on Monday to Thursday and every other Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive P Beck can be reached on 571-272-1415. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).


Kirsten C Jolley
Primary Examiner
Art Unit 1762

kcj